Proceedings of the 2019 International Conference "ECONOMIC SCIENCE FOR RURAL DEVELOPMENT" No 52
Jelgava, LLU ESAF, 9-10 May 2019, pp. 396-402
DOI: 10.22616/ESRD.2019.147

THE FLUCTUATIONS OF MAIZE PRICE IN YEARS 2010-2018 IN POLAND

Katarzyna Utnik-Banas[1], Dr hab. inz.
[1]Institute of Economics and Enterprises Management, University of Agriculture in Krakow, al. Mickiewicza 21, 31-120 Krakow e-mail: rrbanas@cyf-kr.edu.pl

Abstract. The work determines the range of variability in the price of maize in 2010-2018 using time series decomposition. The nominal price of maize increased from 512 PLN/ton in January 2010 to 713 PLN/ton in December 2018. The decomposition of the time series for maize prices indicates regular seasonal and cyclic fluctuations as well as irregular random fluctuations. The seasonal variability of maize prices is highly statistically significant. In 2018, lowest prices of maize (91.7 % of the annual average) were in October, whereas the highest (107.1 %) in August. Changes in prices of maize in 2010 – 2018 were characterized by a cyclicity of 2 to 4 year-long cycles. Annually, on average, cyclic fluctuations amounted to 62 %, seasonal fluctuations 31 % and random 7 % of the total price variability for maize.

Key words: maize, price, variability, time series, seasonality, cyclic fluctuations.
JEL codes: E 30, Q 11, Q 13

Introduction

The price variability is a key aspect of price risk for all market members: producers, processors, as well as consumers (Figiel et al. 2012). The price levels of agricultural raw materials are mainly influenced by: the biological-technical character of agricultural production, low short-term elasticity of supply, inter-market relations and relations to world prices (Hamulczuk and Stanko 2011). Price variability is inevitable, however, it is crucial to know the causes lying behind the variability, which may allow foreseeing or preventing sudden changes in price levels. Characteristic elements of the price variability in agriculture include annual seasonal fluctuations or longer, periodically repetitive cyclic fluctuations. Best known are pig cycles in pork production (Szymanska 2012). Despite numerous studies and a relatively well described mechanism, the occurrence of „pig cycles" has not been eliminated.

Maize has increased economic importance in the word. In 90. of XX century it took third place after weat and rise (Czulowska 2017). The area of cultivation of maize plant develops the most dynamically from all plants in cultivation in Poland country. Maize is grown in our country mainly for fodder and for the spirits industry. When it comes to feed use, two basic directions can be distinguished: intended for grain and for silage from whole plants, which is prepared for ruminants. In 2014, grain maize was grown on the surface above 678 thousand hectares, of which they were collected 4.48 million tons, in 2017 year – respectively 1191 thousand hectares and 4.02 tons. Grain and livestock production are closely related (Mruklik i Jodz 2012). The chemical composition of maize in comparison to other cereals is characterized by the highest stability and low variability in years. The energy value is the highest of all cereals, this is due to the amount contained in the starch grain, the low fibre level and the relatively high level of fat. Maize grain compared to other cereals, is characterized by a relatively low concentration of protein. The amiNo acid composition of the maize protein is far from optimal due to the lack of lysine and tryptophan (Boczar 2018). This fact must be taken into account when composing doses with a high proportion of maize and replenishing both amiNo acids to the necessary level. Maize grain is characterized by the best availability of energy among all cereals.

The aim of the paper is to present the type and the range of variability of maize prices in 2010-2018. In case to achieve the main goal of the study following tasks were formulated: (1)

[1] al. Mickiewicza 21, 31-120 Kraków e-mail: rrbanas@cyf-kr.edu.pl

characterized type of variability by calculation variability coefficient, minimal value and maximal value, maximal monthly change in price and the change in price indicator; (2) describe the type of price fluctuations using the time series analysis.

Research material and methods

The research material was monthly time series for prices of maize in 2010-2018. The prices came from the Integrated System of Agricultural Market Information (2019), whereas the level of maize production in Poland were obtained from the FAOSTAT Database (Faostat 2019).

The range of price variability in a year was presented with a variability coefficient, minimal value and maximal value (interval), maximal monthly change in price (increase or decrease) and the change in price indicator (in %). The analysis of the price variability for maize was conducted with a price time series decomposition. A time series includes the following elements (Dittmann 2008):

Developmental tendency – trend (T) – it shows the long-term tendency for one-way changes (increase or decrease) of the price. It is understood as the effect of the influence of a constant set of factors,

Cyclic fluctuations (C) – they are formed as long-term, rhythmically repetitive price fluctuations around the developmental tendency in time intervals longer than one year,

Seasonal fluctuations (S) – are price fluctuations of the observed variable (price) around the developmental tendency and repeat in a time interval not longer than one year.

Random fluctuations – random element – (I).

Given the mutual relation between the long-term trend (T) and cyclic fluctuations (C) formed by similar factors, the elements of the time series are treated in the paper as a whole trend-cycle element (T_tC_t). To describe the time series for maize prices, a multiplicative model was used in the form of the following formula (Stanko 2013):

$$Y_t = T_t C_t S_t I_t$$

where:

Y_t –price in time t,

T_tC_t – long-term trend and cyclic fluctuations,

S_t – seasonal fluctuations,

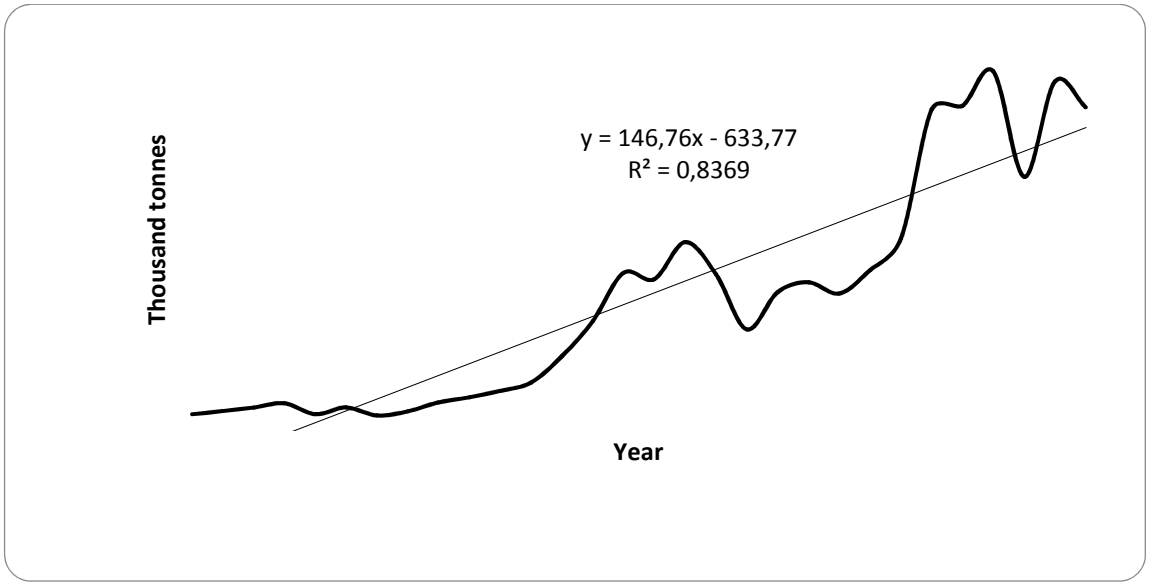
I_t – random fluctuations.

The Census II/X11 [Idzik 2009] method was used to determine the seasonality of indicators. The advantage of Census II/X11 is, among others, the ability to calculate seasonal fluctuations for each year separately, which allows for an analysis of possible changes in seasonality models in longer periods of time. In order to check the relevance of the seasonality indicators, a variance analysis was carried out for indicator values in particular months using the F test.

The influence of particular components of the time series, such as: seasonality (S), random fluctuation (I) and developmental tendency (TC) on the general variability of maize prices was determined in relation to the duration of changes. To this end, the share of variances for particular components of the series in the total price variance was analyzed. The calculations were carried out with a forecasting and time series analysis packet included in the computer program Statistica 9.0 (Kot et al. 2011).

Results

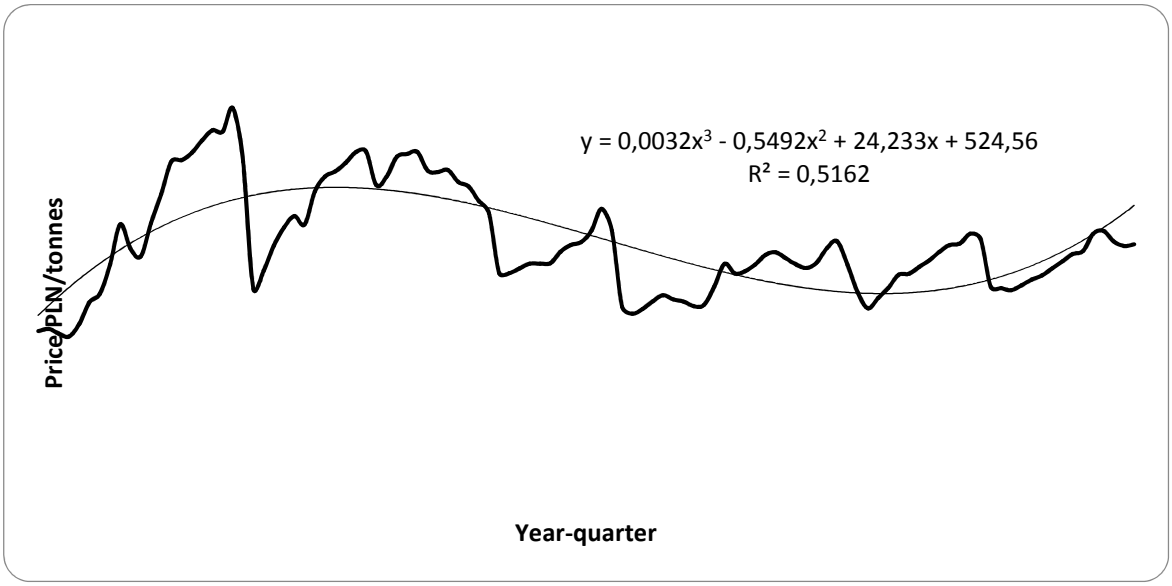
Production of maize in Poland in last three decades increased twenty times from the level of 204 thousand tonnes in 1988 to 4022 thousand tonnes in 2017 year (Fig. 1). The most intensive increase (187 thousand tonnes yearly) took place from 2000 year.



Source: author's calculations based on Faostat Database 2019

Fig. 1. **Production of maize in Poland in years 1998-2017**

Price of maize undergo significant fluctuations. Over last nine years, the nominal price of maize increased from 512 PLN/ton in January 2010 to 713 PLN/ton in December 2018 (Fig. 2).



Source: author's calculations based on Integrated System of Agricultural Market Information, 2019

Fig. 2. **Level of nominal prices of maize in 2010-2018**

The biggest monthly increase (14.1 %) took place in 2010, in which the price rose from 665 PLN/ton in August to 759 PLN/ton in September. The biggest monthly drop (-32.5 %), however, took place in 2011, in which the price decreased from 904 PLN/ton in September to 610 PLN/ton in October (Tab. 1).

In 2010-2014 the price variability coefficient in a year was ranging between 11.6 and 16.5 %, (except year 2012 7.3 %) whereas from 2015 prices in a year were subjected to lower fluctuations, and the variability coefficient was about 7 %.

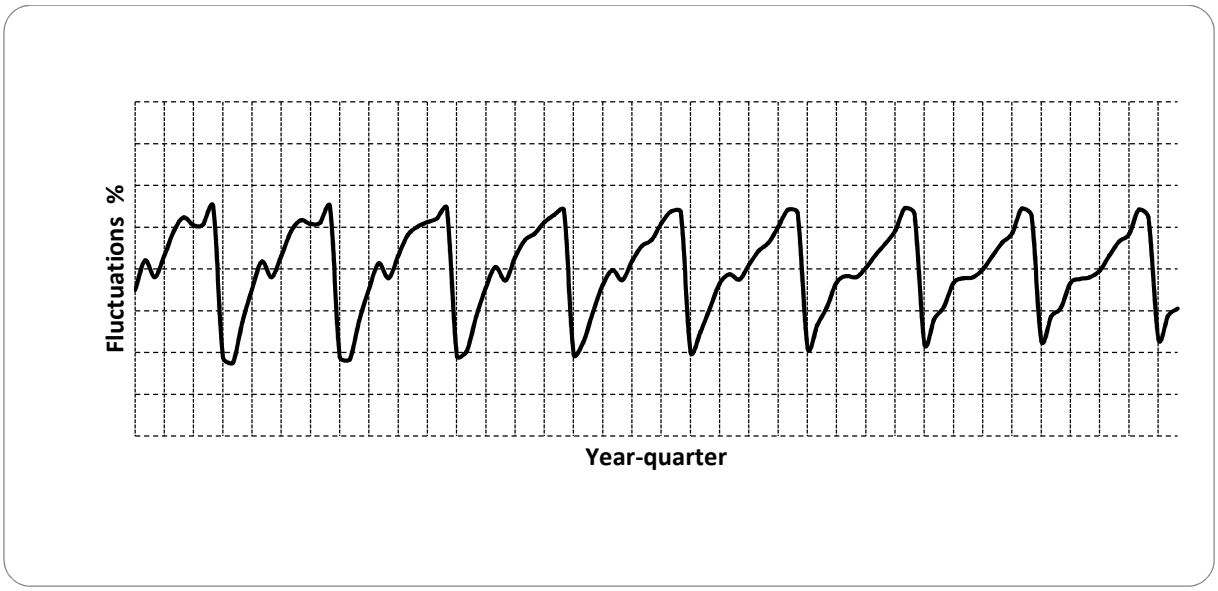
Table 1

Variability of maize prices in 2010-2018

Year	Average	min	max	max/ min	Variability coefficient %	Max monthly %		Index of change	
	PLN kg^{-1}					decrease	increase	yearly	January 2010=1
2010	609	499	762	1.5	16.5	-7.4	14.1	1.5	1.5
2011	865	610	1028	17	15.7	-32.5	9.2	0.9	1.4
2012	855	752	928	1.2	7.3	-8.4	10.0	1.2	1.8
2013	813	646	927	1.4	13.0	-17.7	1.7	0.7	1.3
2014	675	552	795	1.4	11.6	-23.8	6.9	0.8	1.1
2015	618	570	688	1.2	7.0	-3.3	8.5	1.2	1.3
2016	652	565	720	1.3	7.5	-9.6	5.0	0.9	1.2
2017	670	607	738	1.2	7.0	-15.3	4.9	0.9	1.2
2018	686	618	744	1.2	6.1	-3.2	5.7	1.2	1.4

Source: author's calculations based on Integrated System of Agricultural Market Information, 2016

The decomposition of the time series for maize prices indicates regular seasonal and cyclic fluctuations as well as irregular random fluctuations. The steady seasonality test results proved that the seasonal variability of maize prices is highly statistically significant ($p<0.0001$, statistics value $F=27.68$). In the analyzed period there was a slightly change in the model seasonality and a decrease in the amplitude of seasonal fluctuations. In 2010 maize was cheapest (88.7 %) in November and in following months price gradually increased reached the peak (107.5 %) in September (Fig. 3, 4). The amplitude of seasonal fluctuations amounted to 18.8 %.

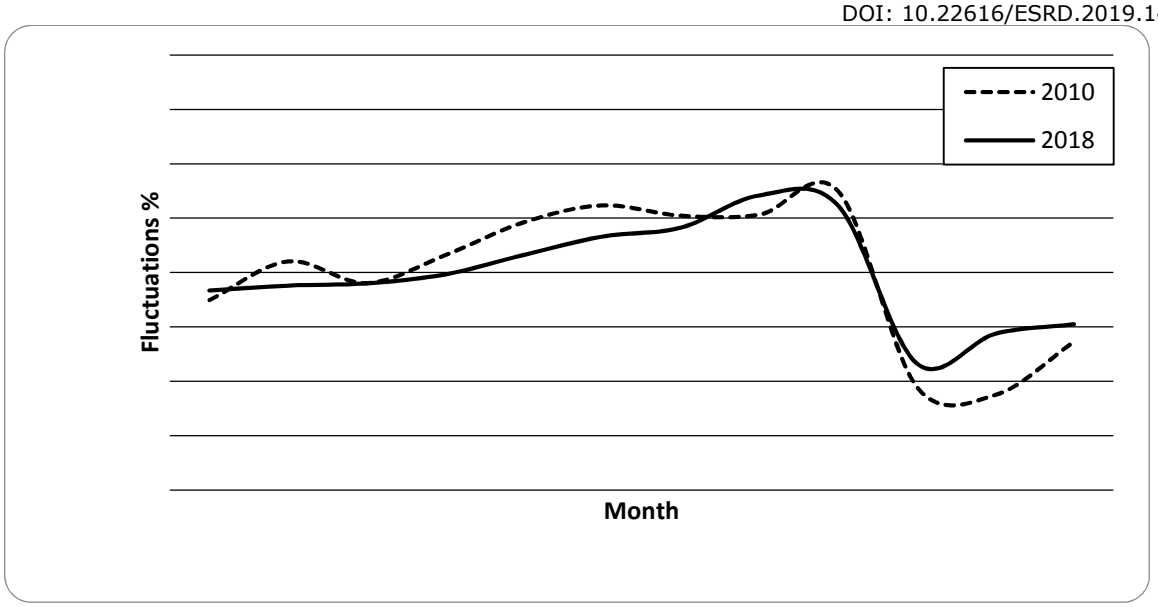


Source: author's calculations based on Integrated System of Agricultural Market Information, 2019

Fig. 3. **Seasonal fluctuations of maize prices in 2010-2018**

In the following years, there was a slightly decrease in the fluctuation amplitude. In 2018, lowest prices of maize (91.7 % of the annual average) were in October, whereas the highest (107.1 %) in August. The share of seasonal fluctuations in a monthly horizon amounted to 46 % of the total price variability, in two-month horizon it was 49 %, and the share dropped under 30 % in a horizon longer than half a year (Tab. 2).

DOI: 10.22616/ESRD.2019.147



Source: author's calculations based on Integrated System of Agricultural Market Information, 2019

Fig. 4. **Changes in the price seasonality model of maize in 2010-2018**

Table 2

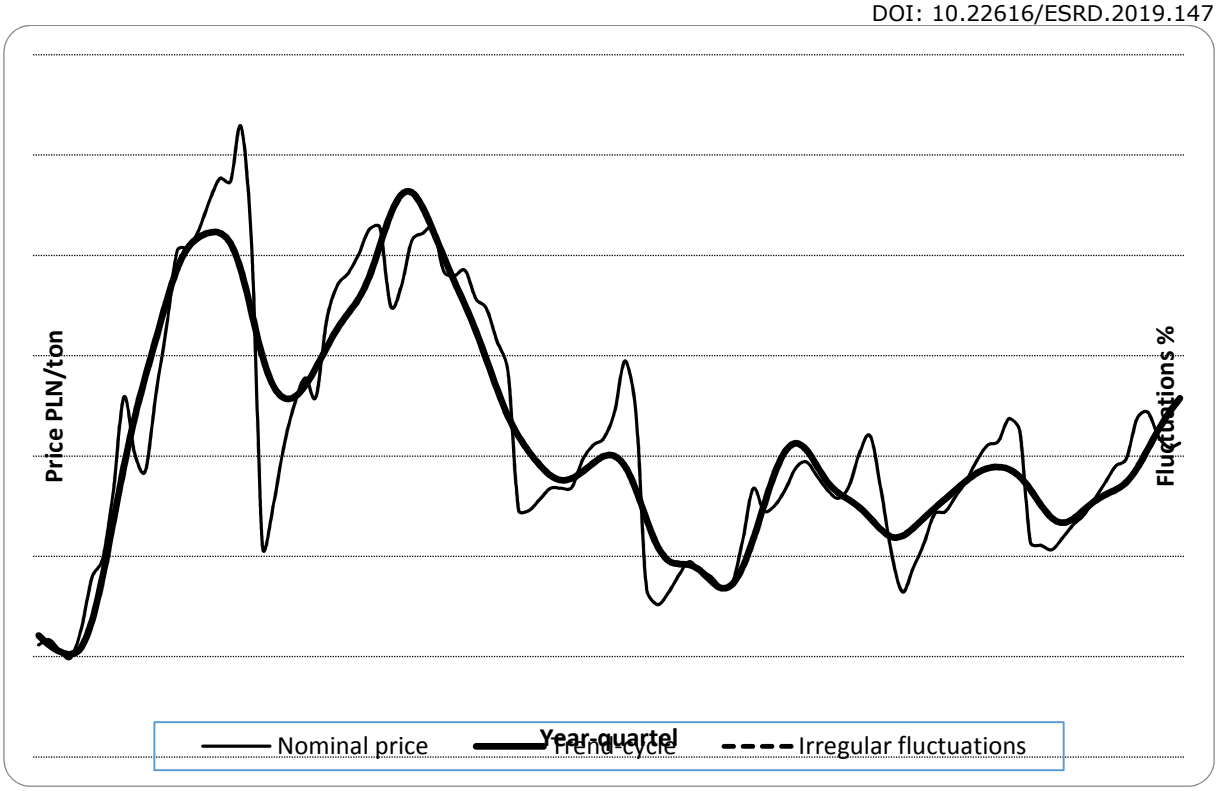
Share of seasonal, cyclic and irregular changes in the total price variability of maize in 2010-2018

Horizon of changes (months)	Changes %		
	irregular	cyclic	seasonal
1	27	27	46
2	14	37	49
3	7	45	48
4	5	52	43
5	3	58	38
6	3	63	34
7	3	69	28
9	2	80	18
11	2	94	4
12	3	97	0
Average	7	62	31

Source: author's calculations based on Integrated System of Agricultural Market Information, 2016

Changes in prices of maize in 2010 – 2018 were characterized by a cyclicity of 2 to 4 year-long cycles (Fig. 5). Bottom turning-points occurred in: April 2010, December 2011, May 2015, October 2016 and January 2018. Top turning-points (peaks) occurred in: May 20011, October 2012, December 2015 and July 2017. The value of MCD = 5.04 indicates that after five months of one-way changes a new cycle occurs. Cyclic fluctuations in a month horizon of changes amounted to 27 % and in a 4 month period their share constituted more than half (52 %) of the total variability (tab.3). Irregular fluctuations in a month horizon of changes amounted to 27 % of the total variability, whereas in a four month horizon their share was 5 %. Annually, on average, cyclic fluctuations amounted to 62 %, seasonal fluctuations 31 % and random 7 % of the total price variability for maize.

DOI: 10.22616/ESRD.2019.147



Source: author's calculations based on Integrated System of Agricultural Market Information, 2019

Fig. 5. **Results of the decomposition of the time series for maize prices**

Discussion and conclusions

Price variability is characteristic of the free market, functioning based on the rule of balance between supply and demand (Figiel et al. 2012). Significant price fluctuations frequent in agriculture are rooted in a relatively poorly flexible in price demand influenced by slow changes and practically fixed supply in short-term, often influenced by quite rapid changes. Figiel (2002) points out that the range of price fluctuations depends greatly on the price efficiency of a given market, expressed as the ability to set a price quickly, objectively reflecting the demand-and-supply situation both at the present moment and in future determined for the given market.

The work determines the range of variability in the price of maize in 2010-2018 using time series decomposition. The nominal price of maize increased from 512 PLN/ton in January 2010 to 713 PLN/ton in December 2018. The decomposition of the time series for maize prices indicates regular seasonal and cyclic fluctuations as well as irregular random fluctuations. The seasonal variability of maize prices is highly statistically significant. In 2018, lowest prices of maize (91.7 % of the annual average) were in October, whereas the highest (107.1 %) in August. Changes in prices of maize in 2010 – 2018 were characterized by a cyclicity of 2 to 4 year-long cycles. Annually, on average, cyclic fluctuations amounted to 62 %, seasonal fluctuations 31 % and random 7 % of the total price variability for maize.

Acknowledgments

The paper was created with the grant support project NCBiR no. BIOSTRATEG2/297910/12/ NCBR/2016

Bibliography

1. Boczar, p. (2018). Plant Protein – Sources, Production Costs and Quality. Problems of World agriculture, 18(4), 122-132, DOI: 10.22630//PRS.2018.18.4.103.
2. Czułowska, M. 2017. Comparative Analysis of Economic Results of Maize Cultivated for Dry and Wet Grain. Roczn. Nauk. SERiA, t. XIX, z.1, 32-37.
3. Dittmann, p. 2008. Prognozowanie w przedsiebiorstwie. Metody i ich zastosowanie. Oficyna Wolters Kluwer Business, Kraków.
4. Faostat 2019. http://www.fao.org/faostat/en/#home (downloaded 22.02.2019).
5. Figiel, S. 2002. Cenowa efektywnosc rynku towarowego na przykładzie zboz w Polsce. Wydawnictwo Uniwersytetu Warminsko−Mazurskiego, Olsztyn.
6. Figiel, S., Hamulczuk, M., Klimkowski, C. 2012. Metodyczne aspekty analizy zmiennosci cen oraz pomiaru ryzyka cenowego na towarowych rynkach rolnych. Komunikaty, Raporty, Ekspertyzy, nr 559, IERiGZ−PIB, Warszawa.
7. Hamulczuk, M. 2009. Analiza, prognozowanie i zarzadzanie ryzykiem cenowym na podstawowych rynkach rolnych – mozliwości stabilizowania dochodów producentów rolnych. IERiGZ−PIB, Warszawa, 149, 1-68.
8. Hamulczuk, M., Stanko, S. 2011 Prognozowanie cen surowcow rolnych - uwarunkowania i metody, Komunikaty, raporty, ekspertyzy nr 547, IERiGZ-PIB, Warszawa. str. 5 – 43.
9. Idzik, M. 2009. Analiza struktury szeregow czasowych cen produktów rolnych. [W:] Zarządzanie ryzykiem cenowym a mozliwosci stabilizowania dochodow producentow rolnych − aspekty poznawcze i aplikacyjne. Red. M. Hamulczuk, S. Stanko. IERiGZ-PIB, Warszawa, 148, 15 – 47.
10. Kot, S., M., Jakubowski, J. Sokołowski, A. (2011) Statystyka, Difin, Warszawa, str. 335 – 357.
11. Mruklik, A., Jodz, K. 2012. An Application of the Correlation Analysis to the Cereals Production and Animal Production in Poland. Uprawa zboz i produkcja zwierzeca w Polsce – analiza zaleznośći. Roczn. Nauk. SERiA, t. XIV, z. 3, 278-281.
12. Olszanska, A. 2012. Rynek zywca w Polsce (1955−2010) – zmiany strukturalne, koncentracja produkcji i wahania podazy. Monografie i opracowania nr 214. Wyd. UE we Wrocławiu.
13. Rembeza, J. 2007. Transmisja cen na rynku miesa. [W:] Ewolucja rynku miesnego i jej wpływ na proces transmisji cen. IERiGZ-PIB, Warszawa, 73, 183 – 213.
14. Stanko, S. (red.) 2013. Prognozowanie w agrobiznesie, teoria i przykłady zastosowania. Wydawnictwo SGGW, Warszawa.
15. Szymanska, E. 2012. Zmiennosc koniunktury na rynku trzody chlewnej w Polsce. Roczn. Nauk. SERiA, t. XIV, z.1, 524−528
16. Integrated System of Agricultural Market Information. 2019. http://www.minrol.gov.pl/pol/ Rynki-rolne [4.02.2019].